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Summary

This report documents the new transport property data that will be used in the NASA Lewis Research Center's Chemical Equilibrium and Applications Program (CEA). It complements a previous publication that documented the thermodynamic and transport property data then in use. Sources of the data and a brief description of the method by which the data were obtained are given. Coefficients to calculate the viscosity, thermal conductivity, and binary interactions are given for either one, or usually, two temperature intervals, typically 300 to 1000 K and 1000 to 5000 K. The form of the transport equation is the same as used previously. The number of species was reduced from the previous database. Many species for which the data were estimated were eliminated from the database. Some ion-neutral interactions were added.

Introduction

This report documents the new transport property data that will be used in the NASA Lewis Research Center's Chemical Equilibrium and Applications Program (CEA). It complements McBride, Gordon, and Reno (1993), which documented the thermodynamic and transport property then in use. In that report, transport data are given for 155 species, 3 unlike interactions, and no ions. The source of the data was from Gordon, McBride, and Zeleznik (1984) for 17 species and from Svehla (1962) for the remaining species. The updated library database described herein includes data for 65 neutral species, 27 unlike neutral interactions, 14 ion-neutral interactions, and electron gas. The number of species reported was significantly reduced by deleting some of the data from Svehla (1962), many of which were for species for which no experimental transport data existed. These data had been estimated by very approximate techniques, and their accuracy cannot be assessed.

During mixture calculations, if no data are found in the transport database for a species, the program uses an empirical equation incorporated in the program to estimate the values. If no data are found for a binary interaction, the program uses a combining rule that determines the values from the data of the pure species. Thus, all the interactions are accounted for.

There is no meaningful way to compare the accuracy of data calculated by the estimating techniques in Svehla (1962) with data calculated by the empirical equation in the current program. Because of this, it was decided to eliminate species for which the data were estimated in Svehla (1962). This also saves computation time and gives program users a more realistic picture of the size of the database included with the program. Even in the reduced database, there is a wide range in accuracy among species. This problem is discussed in the sections following the symbols list.

The report is divided into three main sections: the text, the data source table, and the transport coefficient table. The text explains the information in the tables.

Symbols

A^*	ratio of viscosity to diffusion cross sections, dimensionless
A,B,C,D	constants in equation (2) obtained by fitting data
k	Boltzmann's constant, 1.380658×10^{-23} J/K
Pr	Prandtl number, dimensionless
$S(0010)$	inelastic cross section between translational and internal energy, cm^2
$S(20)$	viscosity cross section, cm^2
T	temperature, K
T^*	reduced temperature, kT/ε, dimensionless
V_0^*	V_0/ε, energy parameter in corresponding states method, dimensionless
Z	collision number, dimensionless
α	steepness parameter in exp-6 potential, dimensionless
δ	polarity parameter in Stockmayer potential, dimensionless
ε/κ	energy parameter in Lennard-Jones, Stockmayer, and exp-6 potentials, K
λ	thermal conductivity, W/cm•K$\times10^{-6}$
η	viscosity, g/cm•s$\times10^{-6}$
$\eta_{(i,j)}$	binary interaction parameter, g/cm•s$\times10^{-6}$
ρ	distance parameter in exponential repulsive potential, cm$\times10^{-8}$

ρ^*	reduced distance parameter in corresponding states method, ρ/σ, dimensionless
σ	size parameter in Lennard-Jones, Stockmayer, and exp-6 potentials, cm$\times 10^{-8}$

Sources and Selection of Data

Table I lists the species included in the database. The first column identifies the interaction. If the names on each side of the hyphen are the same, the data are for the viscosity or thermal conductivity of a pure species. If the names are different, the data are for the binary interaction of the two species shown. The second column indicates the property determined. For unlike interactions, this is always "diffusion," which often provides the source of the data. The computer program uses these binary data for the mixture viscosity and thermal conductivity calculations. The third column gives the source of the data. A more detailed explanation of the methods used to obtain the data is given in the following section.

As discussed previously, the number of species was reduced from that in McBride, Gordon, and Reno (1993) because of the uncertainty in much of the data. Even so, the accuracy of the data included herein varies greatly from species to species. Most of the species have experimental data over a narrow temperature range, typically to about 400 to 500 K. However, some have data to higher temperatures, several to about 2000 K. For temperatures higher than the experimental range, the data were extrapolated by methods discussed in the next section.

The extrapolated data are likely to be less accurate for species with experimental data over a narrow temperature range than for species with data over a wide temperature range. Although no effort was made to estimate differences in accuracy among the data, a comparison of the methods in the third column of table I, and the more detailed description of the methods in the following section, give an idea of the relative accuracy of each.

The selection of species and unlike interactions included was generally based on the importance of the interaction and the availability of the data. Any species or interaction for which experimental data were available over a wide temperature range was included. If the species or interaction was important in aerospace applications, it was included even if experimental data were sparse. Species that were not applicable to aerospace were generally excluded if data were sparse, and hydrocarbons with more than two carbon atoms were excluded. Some ion-neutral interactions were included even though the contribution to the composition below 5000 K was negligible.

Methods of Calculation

This section gives a more detailed explanation of the methods mentioned in the third column of table I. The column briefly describes the method, then gives selected constants and references when applicable. If no reference is given, the work was done for this report. In some cases, the information in table I sufficiently explains the method. But because this is not always true, some background and additional explanation are given here. However, the reasons why one method was chosen over an alternative method for a specific interaction are not given in table I. They are covered in general terms in the following paragraphs.

The viscosity for many species was determined by fitting experimental data to a theoretical form. For nonpolar molecules this was the Lennard-Jones potential, and for polar molecules this was the Stockmayer potential, which simplifies to the Lennard-Jones potential if the dipole moment is zero. Species that are only slightly polar were treated as nonpolar. Collision integrals for the Stockmayer potential were calculated by Monchick and Mason (1961). Their model assumes that the collision trajectories are negligibly distorted by the transfer of internal rotational energy and that the relative orientation of the colliding dipoles remains fixed during the portion of the collision trajectory of the closest approach. Monchick and Mason then averaged the integrals over all orientations with the assumption of an equal probability for all orientations. The final tables were presented as a function of the reduced temperature T^* and the polarity parameter δ. These tables and the experimental data were used herein to adjust the parameters σ, ε/κ, and δ to obtain a best fit to the data. These parameters were then used to extrapolate the data to temperatures above the range of the experimental data. The parameters used and the source of the constants used are given in table I.

For many of the unlike interactions, experimental diffusion data were fit to the modified Buckingham (exp-6) potential when sufficient data were available. The data were extrapolated to higher temperatures from the parameters obtained from the fit, as was done for the Lennard-Jones and Stockmayer potentials.

Another technique recently used for nonpolar molecules is the extended method of corresponding states. The method was developed by Kestin, Ro, and Wakeham (1972), modified and improved by Najafi, Mason, and Kestin (1983), and applied to the noble gases by Kestin et al. (1984). It has since been extended to polyatomic gases by Boushehri et al. (1987) and Bzowski et al. (1990). The method of corresponding states uses four adjustable parameters: two for low and moderate temperatures, and two for high temperatures. The parameters were determined independently for each temperature range. Experimental data were used to determine the low-temperature parameters, and high-energy molecular beam scattering measurements were used for the high-temperature parameters.

The thermal conductivity was obtained by a variety of methods. The thermal conductivity theory is not as well founded for polyatomic gases as for monatomic gases because internal energy, as well as kinetic energy, can be transferred during collisions. This has been treated in several ways. Originally, the thermal conductivity was calculated by including an additional term in the kinetic energy term to account for internal energy exchange. This was the original Eucken equation (Eucken 1913) and, later, the modified Eucken equation (Chapman and Cowling 1939). The modified Eucken equation has been used herein for some species.

Later, Mason and Monchick (1962) and Monchick, Pereira, and Mason (1965) started with the formal results from rigorous kinetic theory and derived expressions for the thermal conductivity. By making suitable approximations, they were able to express the results in terms of measurable quantities, such as relaxation times. The only quantity that posed a problem was an expression involving the transfer of internal energy. This expression has been referred to as the "coefficient of diffusion of internal energy." The thermal conductivity is expressed as the sum of the terms of translational and internal energy, with the internal energy being separated into rotation, vibration, and electronic contributions. These terms are not independent, but are modified by inelastic collisions. The relaxation time for each internal energy mode is expressed in terms of a temperature-dependent collision number. Except at high temperatures, usually only the translational-rotational interaction is needed. Vibration and electronic relaxation times are sufficiently long that they can be treated as independent terms.

This method was used for species for which experimental conductivity data were not available over a wide temperature range. Some simplifying assumptions were made. A single collision number was used, which represented a composite for all internal energy modes, although it generally reflects the translational-rotational exchange. It was assumed to be a constant, independent of temperature. The number was determined by fitting the data at the highest temperature for which experimental data were available, and it was then used for all higher temperatures.

By using results derived by Parker (1959) and Brau and Jonkman (1970) for the temperature dependence, Uribe, Mason, and Kestin (1989) further extended the method to include a correlation with the translational-rotational high-temperature limit for the collision number. Uribe, Mason, and Kestin (1990) applied the technique to nine nonpolar, or very slightly polar, polyatomic gases. Parameters from Boushehri et al. (1987) were used in the calculations, giving a consistent set of viscosity and conductivity data calculated to 3000 °C. However, this method was not used in preference to a simpler method discussed later.

For polar molecules an additional effect is important, especially at low temperatures. This is the resonant exchange of translational and internal energy, in particular rotational energy. The resonant exchange has been studied by Mason and Monchick (1962); Monchick, Pereira, and Mason (1965); and Uribe, Mason, and Kestin (1989). They derived expressions for corrections to the rotational energy diffusion coefficient in terms of the temperature, dipole moment, and moments of inertia. These corrections have been included in the present calculations.

Thijsse et al. (1979) took a different approach. They considered the total heat flux as a starting point in the derivation, rather than separating it into translational and internal energy modes. After writing an expression for the conductivity, they simplified it by dropping a small term near zero. This approximation has been substantiated by Millat, Vesovic, and Wakeham (1988) from experimental viscosity and conductivity data.

A similar approach was used by Van den Oord and Korving (1988). They also considered the total heat flux as a starting point in the derivation, to give an expression for the conductivity in a form as simple as the viscosity. With some reasonable approximations, they formulated the Prandtl number as

$$Pr = \frac{2}{3}\left[1 + \frac{1}{2}\,\frac{S(0010)}{S(20)}\right] \tag{1}$$

where the ratio on the right side of equation (1) is the inelastic cross section for the exchange between translational and internal energy $S(0100)$, divided by the viscosity cross section $S(20)$. The ratio is a positive, slowly varying function of temperature. For an inert monatomic gas, the ratio is zero.

Examination of equation (1) suggests an alternative approach for higher temperatures. Because the ratio is typically a weak, decreasing function of temperature (usually significantly less than unity above room temperature) the Prandtl number is weakly temperature dependent. This offers an alternative means of extrapolating to higher temperatures. When sufficient data are available to calculate the Prandtl number, there is likely to be less uncertainty by extrapolating the Prandtl number, rather than an individual property. This is especially true for the conductivity, which is not on a theoretical basis as sound as that for viscosity. The approach used here was to calculate the Prandtl number from the experimental viscosity and conductivity data, along with calculated specific heats, up to the maximum temperature for which conductivity data were available. The Prandtl number was then graphically extrapolated to 5000 K, using a logarithmic temperature coordinate. Then the conductivity was calculated from the viscosity and specific heats. This technique was most useful when the viscosity and conductivity were known over a wide temperature range, which occurred for a few species.

Table I describes some methods as "theoretical calculations" without further explanation. These were for free radical and ion-neutral interactions, interactions for which experimental data are generally nonexistent. They each involve a multiplicity of potential energy curves, and each curve requires an individual detailed analysis and a calculation of the transport cross sections as a function of temperature. The transport cross sections are then weighted according to the probability of each potential to calculate the total transport property cross section at each temperature. Some interactions have a large number of curves with resulting increased computational requirements. Many of these calculations were done at the NASA Ames Research Center. For a discussion of the details, the reader is referred to the references in table I.

Transport Property Coefficients

The format for the transport property coefficients in the CEA program is given in table II, which is in the same format as in McBride, Gordon, and Reno (1993). The coefficients are given in table III. The format of table III was changed from that in table II in order to improve the readability of the text. The coefficients were generated by a least-squares fit to the following equation:

$$\left.\begin{array}{l}\ln\eta\\ \ln\lambda\\ \ln\eta_{(i,j)}\end{array}\right\} = A\ln T + \frac{B}{T} + \frac{C}{T^2} + D \qquad (2)$$

In equation (2), T is the temperature, η the viscosity, λ the thermal conductivity, and $\eta_{(i,j)}$ a defined term (between species i and j) used in mixture equations (Hirschfelder, Curtiss, and Bird 1954). It is of the same form as the viscosity, and it reduces to the viscosity if i equals j. The $\eta_{(i,j)}$ term can be converted to binary diffusion coefficients if A^*, which is frequently close to 1.1, is known or estimated (Hirschfelder, Curtiss, and Bird 1954). A, B, C, and D are constants obtained by fitting the data. The constants were fitted to generate the viscosity and binary interaction parameter in units of micropoise (μg/cm·s) and the conductivity in units of microwatts per centimeter kelvin (μW/cm·K).

Coefficients were generated for two temperature intervals, usually 300 to 1000 K and 1000 to 5000 K, to be consistent with the thermodynamic and transport data intervals used in McBride, Gordon, and Reno (1993). In some cases the data were given as low as 200 K or as high as 6000 K, when the accuracy of the data warranted the extended range.The calculated data were forced to match at 0.01 K below the specified midpoint temperature.

Typically, each species has four sets of coefficients: two sets for viscosity and two sets for conductivity (low- and high-temperature intervals for each). Only a high-temperature interval is given for interactions involving ions or free radicals, species that do not appear below 1000 K. For the unlike interactions, only one or two sets are given, depending on whether or not a low-temperature interval is included.

Concluding Remarks

The data for the current temperature range are sufficient for all the existing applications in CEA. However, possible new applications, such as hypersonic propulsion, which encounter temperatures above 5000 K, would require data for higher temperatures.

A new version of the NASA Lewis chemical equilibrium program being considered would include thermodynamic data at higher temperatures, possibly as high as 20 000 K (McBride, Gordon, and Reno 1993). The temperature range and transport property database would then be extended to be compatible with the thermodynamic data. This would require the addition of ion-ion interactions and additional ion-neutral interactions. Finally, the thermodynamic data may be expanded from two to three temperature intervals to accommodate higher temperatures. If this is done, the transport data will also need to be expanded to three intervals.

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TABLE I.— DATA SOURCES FOR TRANSPORT PROPERTIES

Interaction	Property	Data source
Ar – Ar	Viscosity	Method of corresponding states (Bich, Millat, and Vogel 1990).
	Conductivity	
$BCl_3 - BCl_3$	Viscosity	Lennard-Jones potential ($\sigma = 5.127$ and $\varepsilon/\kappa = 337.7$) (Svehla 1962).
	Conductivity	Modified Eucken approximation.
$BF_3 - BF_3$	Viscosity	Lennard-Jones potential ($\sigma = 4.198$ and $\varepsilon/\kappa = 186.3$) (Svehla 1962).
	Conductivity	Modified Eucken approximation with correction for rotational energy transfer. $Z = 2$ for all temperatures.
$Br_2 - Br_2$	Viscosity	Lennard-Jones potential ($\sigma = 4.296$ and $\varepsilon/\kappa = 507.9$) (Svehla 1962).
	Conductivity	Modified Eucken approximation with correction for rotational energy transfer. $Z = 2$ for all temperatures.
C – C	Viscosity	Theoretical calculations (Biolsi, Rainwater, and Holland 1982).
	Conductivity	
$CClF_3 - CClF_3$	Viscosity	Lennard-Jones potential ($\sigma = 4.93$ and $\varepsilon/\kappa = 200$). Obtained from viscosity data.
	Conductivity	Modified Eucken approximation with correction for rotational energy transfer. $Z = 1$ for all temperatures.
$CCl_2F_2 - CCl_2F_2$	Viscosity	Lennard-Jones potential ($\sigma = 5.25$ and $\varepsilon/\kappa = 253$). Obtained from viscosity data.
	Conductivity	Modified Eucken approximation above 400 K.
$CCl_3F - CCl_3F$	Viscosity	Lennard-Jones potential ($\sigma = 5.44$ and $\varepsilon/\kappa = 334$). Obtained from viscosity data.
	Conductivity	Modified Eucken approximation with correction for rotational energy transfer. $Z = 1$ above 300 K.
$CCl_4 - CCl_4$	Viscosity	Lennard-Jones potential ($\sigma = 5.820$ and $\varepsilon/\kappa = 350$). Obtained from viscosity data.
	Conductivity	Modified Eucken approximation with correction for rotational energy transfer. $Z = 1$ for all temperatures.
$CF_4 - CF_4$	Viscosity	Experimental data were fitted at low temperatures (Assael et al. 1990). The corresponding states method was used at high temperatures ($\sigma = 4.579$, $\varepsilon/\kappa = 156.5$, $\rho^* = 0.0200$, and $V_0^* = 1.460 \times 10^{19}$) (Boushehri et al. 1987). High- and low-temperature data were forced to agree at 1000 K. Above 1000 K, the high-temperature data were adjusted in proportion to the ratio at 1000 K.
	Conductivity	Experimental data were fitted at low temperatures (Assael et al. 1990). The Prandtl number was calculated up to 700 K and extrapolated to 5000 K. The conductivity was calculated from the viscosity and heat capacity from 700 to 5000 K.
$CHClF_2 - CHClF_2$	Viscosity	Stockmayer potential ($\sigma = 4.68$, $\varepsilon/\kappa = 261$, and $\delta = 0.25$). Obtained from viscosity data.
	Conductivity	Modified Eucken approximation with correction for rotational energy transfer. $Z = 5$ above 300 K.
$CHCl_2F - CHCl_2F$	Viscosity	Stockmayer potential ($\sigma = 5.00$, $\varepsilon/\kappa = 300$, and $\delta = 0.25$). Obtained from viscosity data.
	Conductivity	Modified Eucken approximation with correction for rotational energy transfer. $Z = 14$ above 400 K.

TABLE I.— DATA SOURCES FOR TRANSPORT PROPERTIES (continued)

Interaction	Property	Data source
$CHCl_3-CHCl_3$	Viscosity	Lennard-Jones potential (σ = 5.389 and ε/κ = 340.2) (Svehla 1962).
	Conductivity	Modified Eucken approximation with correction for rotational energy transfer. Z = 20 above 400 K.
CHF_3-CHF_3	Viscosity	Stockmayer potential (σ = 4.39, ε/κ = 180, and δ = 0.50). Obtained from viscosity data.
	Conductivity	Modified Eucken approximation with correction for rotational energy transfer. Z = 1 above 300 K.
$CH_2Cl_2-CH_2Cl_2$	Viscosity	Stockmayer potential (σ = 4.52, ε/κ = 483, and δ = 0.20). Obtained from viscosity data.
	Conductivity	Modified Eucken approximation with correction for rotational energy transfer. Z = 4 above 300 K.
CH_3Cl-CH_3Cl	Viscosity	Stockmayer potential (σ = 3.94, ε/κ= 414, and δ = 0.50) (Monchick and Mason 1961).
	Conductivity	Modified Eucken approximation with correction for rotational energy transfer. Z = 2 above 400 K.
CH_4-CH_4	Viscosity	Experimental data were fitted at low temperatures (Trengove and Wakeham 1987). The corresponding states method was used at high temperatures (σ = 3.721, ε/κ = 161.4, ρ^* = 0.0698, and V_0^* = 3.066×10^6) (Boushehri et al. 1987). High- and low-temperature data were forced to agree at 1000 K. Above 1000 K the high-temperature data were adjusted in proportion to the ratio at 1000 K.
	Conductivity	Experimental data were fitted at low temperatures (Assael et al. 1990). The Prandtl number was calculated up to 900 K and extrapolated to 5000 K. The conductivity was calculated from the viscosity and heat capacity from 900 to 5000 K.
CH_4-O_2	Diffusion	Exp-6 potential (σ = 4.229, ε/κ = 100, and α = 12). Obtained from diffusion data.
CH_3OH-CH_3OH	Viscosity	Stockmayer potential (σ = 3.69, ε/κ = 417, and δ = 0.50) (Monchick and Mason 1961).
	Conductivity	Modified Eucken approximation with correction for rotational energy transfer. Z = 1 above 500 K.
$CO-CO$	Viscosity	Same as N_2-N_2.
	Conductivity	
$CO-N_2$	Diffusion	Same as N_2-N_2.
$CO-O_2$	Diffusion	Exp-6 potential (σ = 4.396, ε/κ = 50, and α = 12). Obtained from diffusion data.
$COS-COS$	Viscosity	Lennard-Jones potential (σ = 4.130 and ε/κ = 336.0) (Svehla 1962).
	Conductivity	Modified Eucken approximation.
CO_2-CO_2	Viscosity	Experimental data were fitted at low temperatures (Vesovic et al. 1990). The corresponding states method was used at high temperatures (σ = 3.769, ε/κ = 245.3, ρ^* = 0.0720, and V_0^* = 2.800×10^6) (Boushehri et al. 1987). High- and low-temperature data were forced to agree at 1000 K. Above 1000 K, the high-temperature data were adjusted in proportion to the ratio at 1000 K.
	Conductivity	Experimental data were fitted at low temperatures. The Prandtl number was calculated up to 1800 K and extrapolated to 5000 K. The conductivity was calculated from the viscosity and heat capacity from 1800 to 5000 K.
CO_2-H_2	Diffusion	Exp-6 potential (σ = 3.646, ε/κ = 150, and α = 12). Obtained from diffusion data.
CO_2-H_2O	Diffusion	Exp-6 potential (σ = 3.166, ε/κ = 400, and α = 12). Obtained from diffusion data.

TABLE I.— DATA SOURCES FOR TRANSPORT PROPERTIES (continued)

Interaction	Property	Data source
CO_2–N_2	Diffusion	Exp-6 potential ($\sigma = 4.408$, $\varepsilon/\kappa = 100$, and $\alpha = 12$). Obtained from diffusion data.
CO_2–O_2	Diffusion	Exp-6 potential ($\sigma = 3.772$, $\varepsilon/\kappa = 250$, and $\alpha = 15$). Obtained from diffusion data.
CS_2–CS_2	Viscosity	Lennard-Jones potential ($\sigma = 4.483$ and $\varepsilon/\kappa = 467$) (Svehla 1962).
	Conductivity	Modified Eucken approximation.
C_2H_2–C_2H_2	Viscosity	Lennard-Jones potential ($\sigma = 4.033$ and $\varepsilon/\kappa = 231.8$) (Svehla 1962).
	Conductivity	Experimental data to 600 K (Touloukian, Liley, and Saxena 1970). Modified Eucken approximation with correction for rotational energy transfer above 600 K. Z = 7 above 600 K.
C_2H_4–C_2H_4	Viscosity	Corresponding states method ($\sigma = 4.071$, $\varepsilon/\kappa = 244.3$, $\rho^* = 0.0698$, and $V_0^* = 3.066\times10^6$) (Boushehri et al. 1987). Constants ρ^* and V_0^* were set equal to those of CH_4.
	Conductivity	Experimental data to 500 K (Holland, Eaton, and Hanley 1983). Modified Eucken approximation above 500 K.
C_2H_6–C_2H_6	Viscosity	Corresponding states method ($\sigma = 4.371$, $\varepsilon/\kappa = 241.9$, $\rho^* = 0.0698$, and $V_0^* = 3.066\times10^6$) (Boushehri et al. 1987). Constants ρ^* and V_0^* were set equal to those of CH_4.
	Conductivity	Modified Eucken approximation.
C_2H_5OH–C_2H_5OH	Viscosity	Stockmayer potential ($\sigma = 4.41$, $\varepsilon/\kappa = 400$, and $\delta = 0.25$). Obtained from viscosity data.
	Conductivity	Modified Eucken approximation with correction for rotational energy transfer. Z = 1 above 400 K.
C_2N_2–C_2N_2	Viscosity	Lennard-Jones potential ($\sigma = 4.361$ and $\varepsilon/\kappa = 348.6$) (Svehla 1962).
	Conductivity	Modified Eucken approximation.
Cl_2–Cl_2	Viscosity	Lennard-Jones potential ($\sigma = 4.235$ and $\varepsilon/\kappa = 300$). Obtained from viscosity data.
	Conductivity	Modified Eucken approximation.
D_2–D_2	Viscosity	The viscosity of H_2 was adjusted by the D_2/H_2 ratio of molecular weights.
	Conductivity	Modified Eucken approximation.
D_2O–D_2O	Viscosity	The viscosity data of H_2O was adjusted by the D_2O/H_2O viscosity ratio of Matsunaga and Nagashima (1983). The ratio at 1000 K was used for all temperatures above 1000 K.
	Conductivity	Conductivity data of H_2O was adjusted by the D_2O/H_2O conductivity ratio of Matsunaga and Nagashima (1983). The ratio at 1000 K was used for all temperatures above 1000 K.
e–e	Viscosity	Calculated for an electron pressure of 1 atm (Mason, Munn, and Smith 1967).
	Conductivity	Calculated for an electron pressure of 1 atm (Mason, Munn, and Smith 1967).
e–H	Diffusion	Theoretical calculations (Capitelli, Gorse, and Fauchais 1976). A^* assumed equal to 1.1.
e–H_2	Diffusion	Theoretical calculations (Capitelli, Gorse, and Fauchais 1976). A^* assumed equal to 1.1.
e–NO	Diffusion	Gupta et al. (1990).
e–N_2	Diffusion	Gupta et al. (1990).
e–O	Diffusion	Gupta et al. (1990).
e–O_2	Diffusion	Gupta et al. (1990).

TABLE I.— DATA SOURCES FOR TRANSPORT PROPERTIES (continued)

Interaction	Property	Data source
F_2–F_2	Viscosity	Lennard-Jones potential (σ = 3.357 and ε/κ = 112.6) (Svehla 1962).
	Conductivity	Modified Eucken approximation with correction for rotational energy transfer. Z = 5 for all temperatures.
H–H	Viscosity	Theoretical calculations (Vanderslice et al. 1962).
	Conductivity	
H–H^+	Diffusion	Theoretical calculations (Capitelli, Gorse, and Fauchais 1976). A^* assumed equal to 1.1.
H–H_2	Diffusion	Theoretical calculations (Tang and Wei 1974). Diffusion coefficients converted to $\eta_{(1,2)}$ from A^* of Vanderslice et al. (1962).
H–Li	Diffusion	Theoretical calculations (Krupenie, Mason, and Vanderslice 1963).
H–N	Diffusion	Theoretical calculations (Stallcop, Bauschlicher, Partridge, Langhoff, and Levin 1992).
H–N_2	Diffusion	Theoretical calculations (Stallcop, Partridge, Walch, and Levin 1992).
H–O	Diffusion	Theoretical calculations (Krupenie, Mason, and Vanderslice 1963).
HBr–HBr	Viscosity	Stockmayer potential (σ = 3.41, ε/κ = 418, and δ = 0.147) (Zeleznik and Svehla 1970).
	Conductivity	Modified Eucken approximation with correction for rotational energy transfer. Z = 1 above 400 K.
HCN–HCN	Viscosity	Stockmayer potential (σ = 3.06, ε/κ = 400, and δ = 2.5) (Zeleznik and Svehla 1970).
	Conductivity	Modified Eucken approximation with correction for rotational energy transfer. Z = 1 for all temperatures.
HCl–HCl	Viscosity	Stockmayer potential (σ = 3.32, ε/κ = 340, and δ = 0.35). Obtained from viscosity data.
	Conductivity	Modified Eucken approximation with correction for rotational energy transfer. Z = 1 above 400 K.
HF–HF	Viscosity	Stockmayer potential (σ = 2.49, ε/κ = 286, and δ = 2.5). Obtained from viscosity data.
	Conductivity	Modified Eucken approximation with correction for rotational energy transfer. Z = 6 for all temperatures.
HF–H_6F_6	Diffusion	Lennard-Jones potential (σ = 4.2 and ε/κ = 400). Obtained from thermal conductivity data.
HI–HI	Viscosity	Lennard-Jones potential (σ = 4.211 and ε/κ = 288.7) (Svehla 1962).
	Conductivity	Modified Eucken approximation.
H_2–H_2	Viscosity	Experimental data were fitted at low temperatures (Assael, Mixafendi, and Wakeham 1986). The corresponding states method was used at high temperatures (Boushehri et al. 1987), with σ = 2.968 and ε/κ = 33.3 obtained from Assael, Mixafendi, and Wakeham (1986), and ρ^* = 0.11785 and V_0^* = 4.06×10^4 obtained from Vanderslice and Mason (1960). High- and low-temperature data were forced to agree at 2200 K. Above 2200 K, the high-temperature data were adjusted in proportion to the ratio at 2200 K.
	Conductivity	Experimental data were fitted at low temperatures (Assael, Mixafendi, and Wakeham 1986). The modified Eucken equation was used to calculate conductivity from 500 to 5000 K.
H_2–H_2O	Diffusion	Lennard-Jones potential (σ = 2.718 and ε/κ = 159). Obtained from experimental diffusion data (Svehla 1964).
H_2–N_2	Diffusion	Exp-6 potential (σ = 3.836, ε/κ = 43, and α = 15). Obtained from diffusion data.
H_2–O_2	Diffusion	Exp-6 potential (σ = 3.485, ε/κ = 100, and α = 12). Obtained from diffusion data.

TABLE I.— DATA SOURCES FOR TRANSPORT PROPERTIES (continued)

Interaction	Property	Data source
H_2O-H_2O	Viscosity	Low-temperature data up to 1073 K were obtained from Sengers and Watson (1986). Data between 1077 and 1344 K were obtained from Latto (1965). Above 1344 K the Stockmayer potential parameters of Matsunaga and Nagashima (1983) were used ($\sigma = 2.595$, $\varepsilon/\kappa = 470$, and $\delta = 1.50$).
	Conductivity	Low-temperature data up to 1073 K were obtained from Sengers and Watson (1986). The calculations of Matsunaga and Nagashima (1983) were used from 1200 to 2000 K. The Prandtl number was then calculated up to 2000 K and extrapolated to 5000 K. The conductivity was calculated from the viscosity and heat capacity from 2000 to 5000 K.
H_2O-N_2	Diffusion	Lennard-Jones potential ($\sigma = 2.947$ and $\varepsilon/\kappa = 240$). Parameters were obtained from combining rules.
H_2O-O_2	Diffusion	Exp-6 potential ($\sigma = 3.700$, $\varepsilon/\kappa = 100$, and $\alpha = 15$). Obtained from diffusion data.
H_2S-H_2S	Viscosity	Stockmayer potential ($\sigma = 3.442$, $\varepsilon/\kappa = 380$, and $\delta = 0.22$) (Zeleznik and Svehla 1970).
	Conductivity	Modified Eucken approximation with correction for rotational energy transfer. $Z = 0.5$ for all temperatures.
$H_6F_6-H_6F_6$	Viscosity	Lennard-Jones potential ($\sigma = 5.91$ and $\varepsilon/\kappa = 559$). Parameters were estimated.
	Conductivity	Modified Eucken approximation.
He–He	Viscosity	Method of corresponding states (Bich, Millat, and Vogel 1990).
	Conductivity	
$He-N_2$	Diffusion	Exp-6 potential ($\sigma = 3.262$, $\varepsilon/\kappa = 50$, and $\alpha = 12$). Obtained from diffusion data.
I_2-I_2	Viscosity	Lennard-Jones potential ($\sigma = 5.160$ and $\varepsilon/\kappa = 474.2$) (Svehla 1962).
	Conductivity	Modified Eucken approximation.
Kr–Kr	Viscosity	Method of corresponding states (Bich, Millat, and Vogel 1990).
	Conductivity	
Li–Li	Viscosity	Theoretical calculations (Holland, Biolsi, and Rainwater 1986).
	Conductivity	
N–N	Viscosity	Theoretical calculations (Levin, Partridge, and Stallcop 1990).
	Conductivity	
$N-N^+$	Diffusion	Theoretical calculations (Stallcop, Partridge, and Levin 1991).
N–NO	Diffusion	Derived from molecular beam scattering data and fitted to exponential repulsive potential (Cubley and Mason 1975).
$N-N_2$	Diffusion	
N–O	Diffusion	Theoretical calculations (Levin, Partridge, and Stallcop 1990).
$N-O^+$	Diffusion	Theoretical calculations (Partridge, Stallcop, and Levin 1991).
$N-O_2$	Diffusion	Derived from molecular beam scattering data and fitted to exponential repulsive potential (Cubley and Mason 1975).
N^+-O	Diffusion	Theoretical calculations (Partridge, Stallcop, and Levin 1991).

TABLE I.— DATA SOURCES FOR TRANSPORT PROPERTIES (continued)

Interaction	Property	Data source
NH_3-NH_3	Viscosity	Experimental data were fitted to 700 K. Above 700 K the Stockmayer potential was used ($\sigma = 2.969$, $\varepsilon/\kappa = 460$, and $\delta = 0.65$) (Zeleznik and Svehla 1970).
	Conductivity	Experimental data were fitted to 700 K. The Prandtl number was calculated to 700 K and extrapolated to 5000 K. The conductivity was calculated from the viscosity and heat capacity from 700 to 5000 K.
NO–NO	Viscosity	Method of corresponding states ($\sigma = 3.474$, $\varepsilon/\kappa = 125.0$, $\rho^* = 0.0883$, and $V_0^* = 2.145\times10^5$) (Boushehri et al. 1987).
	Conductivity	Experimental data were fitted to 900 K. The Prandtl number was calculated to 900 K and extrapolated to 5000 K. The conductivity was calculated from the viscosity and heat capacity from 900 to 5000 K.
NO–O	Diffusion	Derived from molecular beam scattering data and fitted to exponential repulsive potential (Cubley and Mason 1975).
NO^+-N_2	Diffusion	Gupta et al. (1990).
NO^+-O	Diffusion	
NOCl–NOCl	Viscosity	Stockmayer potential ($\sigma = 3.88$, $\varepsilon/\kappa = 450$, and $\delta = 0.50$). Obtained from viscosity data.
	Conductivity	Modified Eucken approximation with correction for rotational energy transfer. $Z = 1$ for all temperatures.
NO_2-NO_2	Viscosity	Lennard-Jones potential ($\sigma = 3.765$ and $\varepsilon/\kappa = 210$) (Svehla and Brokaw 1966).
	Conductivity	Modified Eucken approximation.
N_2-N_2	Viscosity	Experimental data were fitted at low temperatures (Stephan, Krauss, and Laesecke 1987). The corresponding states method was used at high temperatures ($\sigma = 3.652$, $\varepsilon/\kappa = 98.4$, $\rho^* = 0.1080$, and $V_0^* = 5.308\times10^4$) (Boushehri et al. 1987). High- and low-temperature data were forced to agree at 2200 K. Above 2200 K, the high-temperature data were adjusted in proportion to the ratio at 2200 K.
	Conductivity	Experimental data were fitted at low temperatures at NASA Lewis. The Prandtl number was calculated up to 2200 K and extrapolated to 5000 K. The conductivity was calculated from the viscosity and heat capacity from 2200 to 5000 K.
N_2-O	Diffusion	Derived from molecular beam scattering data and fitted to exponential repulsive potential (Cubley and Mason 1975).
N_2-O^+	Diffusion	Gupta et al. 1990.
N_2-O_2	Diffusion	Same as $CO-O_2$.
N_2O-N_2O	Viscosity	Method of corresponding states ($\sigma = 3.703$, $\varepsilon/\kappa = 266.8$, $\rho^* = 0.0730$, and $V_0^* = 2.600\times10^6$) (Boushehri et al. 1987).
	Conductivity	Method of corresponding states (Uribe, Mason, and Kestin 1990).
$N_2O_4-N_2O_4$	Viscosity	Lennard-Jones potential ($\sigma = 4.621$ and $\varepsilon/\kappa = 347$) (Svehla and Brokaw 1966).
	Conductivity	Modified Eucken approximation.
Na–Na	Viscosity	Theoretical calculations (Holland and Biolsi 1987).
	Conductivity	

TABLE I.— DATA SOURCES FOR TRANSPORT PROPERTIES (concluded)

Interaction	Property	Data source
Ne–Ne	Viscosity	Method of corresponding states (Bich, Millat, and Vogel 1990).
	Conductivity	
O–O	Viscosity	Theoretical calculations (Levin, Partridge, and Stallcop 1990).
	Conductivity	
$O-O^+$	Diffusion	Theoretical calculations (Stallcop, Partridge, and Levin 1991).
$O-O_2$	Diffusion	Derived from molecular beam scattering data and fitted to exponential repulsive potential (Cubley and Mason 1975).
OH–OH	Viscosity	Stockmayer potential ($\sigma = 2.490$, $\varepsilon/\kappa = 257$, and $\delta = 2.50$). Constants were estimated from HF–HF.
	Conductivity	Modified Eucken approximation with correction for rotational energy transfer. $Z = 1$ for all temperatures.
O_2-O_2	Viscosity	Experimental data were fitted at low temperatures (Laesecke, et al. 1990). The corresponding states method was used at high temperatures ($\sigma = 3.407$, $\varepsilon/\kappa = 121.1$, $\rho^* = 0.0745$, and $V_0^* = 1.322\times10^6$) (Boushehri et al. 1987). High- and low-temperature data were forced to agree at 2000 K. Above 2000 K the high-temperature data were adjusted in proportion to the ratio at 2000 K.
	Conductivity	Experimental data were fitted at low temperatures at NASA Lewis. The Prandtl number was calculated up to 1600 K and extrapolated to 5000 K. Conductitvity was calculated from the viscosity and heat capacity from 1600 to 5000 K.
SF_6-SF_6	Viscosity	Experimental data were fitted at low temperatures (Trengove and Wakeham 1987). The corresponding states method was used at high temperatures ($\sigma = 5.252$, $\varepsilon/\kappa = 207.7$, $\rho^* = 0.0500$, and $V_0^* = 4.067\times10^8$) (Boushehri et al. 1987). High- and low-temperature data were forced to agree at 900 K. Above 900 K, the high-temperature data were adjusted in proportion to the ratio at 900 K.
	Conductivity	Experimental data were fitted at low temperatures at NASA Lewis. The Prandtl number was calculated up to 900 K and extrapolated to 5000 K. The conductivity was calculated from the viscosity and heat capacity from 900 to 5000 K.
SO_2-SO_2	Viscosity	Experimental data were fitted to 1200 K. Above 1200 K the Stockmayer potential was used ($\sigma = 3.919$, $\varepsilon/\kappa = 390$, and $\delta = 0.41$) (Zeleznik and Svehla 1970).
	Conductivity	Experimental data were fitted to 800 K. The Prandtl number was calculated to 800 K and extrapolated to 5000 K. The conductivity was calculated from the viscosity and heat capacity from 800 to 5000 K.
$SiCl_4-SiCl_4$	Viscosity	Lennard-Jones potential ($\sigma = 6.170$ and $\varepsilon/\kappa = 330$). Obtained from viscosity data.
	Conductivity	Modified Eucken approximation with correction for rotational energy transfer. $Z = 1$ for all temperatures.
SiF_4-SiF_4	Viscosity	Lennard-Jones potential ($\sigma = 4.880$ and $\varepsilon/\kappa = 171.9$) (Svehla 1962).
	Conductivity	Modified Eucken approximation with correction for rotational energy transfer. $Z = 1$ for all temperatures.
SiH_4-SiH_4	Viscosity	Lennard-Jones potential ($\sigma = 4.084$ and $\varepsilon/\kappa = 207.6$) (Svehla 1962).
	Conductivity	Modified Eucken approximation.
UF_6-UF_6	Viscosity	Lennard-Jones potential ($\sigma = 5.967$ and $\varepsilon/\kappa = 236.8$) (Svehla 1962).
Xe–Xe	Viscosity	Method of corresponding states (Bich, Millat, and Vogel 1990).
	Conductivity	

TABLE II.—FORMAT FOR TRANSPORT PROPERTY DATA IN CHEMICAL EQUILIBRIUM AND APPLICATIONS PROGRAM (CEA)

Records	Contents	Format	Columns
[a]1	Species name	A15	1-15
	Second species name if binary interaction (blank for pure species)	A15	17-31
	V if there are viscosity coefficients	A1	35
	Temperature intervals for viscosity (0,1,2, or 3)	I1	36
	C if there are thermal conductivity coefficients	A1	37
	Temperature intervals for thermal conductivity (0,1,2, or 3)	I1	38
	Comments (references, date, etc.)	A40	41-80
[b]Any number from 1 to 6	V if coefficients are for viscosity	A1	2
	C if coefficients are for thermal conductivity	A1	2
	First and last temperature of temperature interval	2F9.2	3-20
	Four coefficients in equations below[c]	4E15.8	21-80

[a]Header record for each pure species or binary interaction.

[b]The number of records for each pure species or binary interaction equals the sum of the number of temperature intervals for both viscosity and thermal conductivity (sum of the numbers in columns 36 and 38 of the header record). Temperature intervals must be in increasing order. Viscosity or thermal conductivity order is immaterial. Any number of species is permitted between the first record (tran) and the last record (end).

[c]The empirical equations follow (coefficients are different for each property):

$$\left.\begin{array}{ll}\text{Viscosity:} & \ln\eta \\ \text{Thermal conductivity:} & \ln\lambda \\ \text{Interaction parameter:} & \ln\eta_{(i,j)}\end{array}\right\} = A\ln T + \frac{B}{T} + \frac{C}{T^2} + D$$

TABLE III.—VISCOSITY AND THERMAL CONDUCTIVITY COEFFICIENTS FOR VARIOUS SPECIES

Type of coefficients	Temperature interval, K		Transport property coefficients $\left.\begin{matrix}\ln\eta\\ \ln\lambda\\ \ln\eta_{(i,j)}\end{matrix}\right\} = A\ln T + \frac{B}{T} + \frac{C}{T^2} + D$			
	Lowest	Highest	A	B	C	D
Ar						
Viscosity	200.0	1000.0	0.61205763	-67.714354	190.40660	2.1588272
Viscosity	1000.0	5000.0	0.69357334	70.953943	-28 386.007	1.4856447
Conductivity	200.0	1000.0	0.60968928	-70.892249	584.20624	1.9337152
Conductivity	1000.0	5000.0	0.69075463	62.676058	-25 667.413	1.2664189
BCl_3						
Viscosity	300.0	1000.0	0.52572590	-278.03504	19 159.256	2.4373790
Viscosity	1000.0	5000.0	0.62929553	-60.723560	-37 711.618	1.5615047
Conductivity	300.0	1000.0	0.41518585	-481.49960	30 788.060	3.3168239
Conductivity	1000.0	5000.0	0.61148589	-181.67042	-20 976.969	1.7127671
BF_3						
Viscosity	300.0	1000.0	0.58778079	-96.213686	-376.60007	2.1035273
Viscosity	1000.0	5000.0	0.64430285	7.3362845	-23 890.605	1.6330508
Conductivity	300.0	1000.0	0.39288181	-537.81426	39 023.491	4.2287006
Conductivity	1000.0	5000.0	0.60695214	-198.89031	-23 403.767	2.4734586
Br_2						
Viscosity	300.0	1000.0	0.45241871	-525.42766	61 354.230	3.5322870
Viscosity	1000.0	5000.0	0.60111079	-224.99274	-14 517.179	2.2805949
Conductivity	300.0	1000.0	0.13579199	-801.37295	83 046.621	4.8052172
Conductivity	1000.0	5000.0	0.13602376	-2190.4601	777 699.13	5.4980508
C						
Viscosity	1000.0	6000.0	0.78800513	115.90201	-44 179.578	0.21080136
Conductivity	1000.0	6000.0	0.78776422	114.37429	-43 271.035	1.1670654
$CClF_3$						
Viscosity	300.0	1000.0	0.57775962	-115.95656	1 389.4846	2.0719367
Viscosity	1000.0	5000.0	0.64278913	1.8533422	-25 000.775	1.5313091
Conductivity	300.0	1000.0	0.30701673	-586.21120	37 562.739	4.5977739
Conductivity	1000.0	5000.0	0.59447897	-254.05493	15 214.514	2.3022470
CCl_2F_2						
Viscosity	300.0	1000.0	0.55188576	-180.84616	7 439.9094	2.2089157
Viscosity	1000.0	5000.0	0.63820813	-16.395245	-31 624.406	1.4872353
Conductivity	300.0	1000.0	0.37505967	-459.75338	13 246.268	3.8355232
Conductivity	1000.0	5000.0	0.59226968	-259.88712	21 916.978	2.1265525
CCl_3F						
Viscosity	300.0	1000.0	0.52599241	-274.66441	18 699.061	2.3965367
Viscosity	1000.0	5000.0	0.62963969	-58.775545	-37 421.689	1.5207986
Conductivity	300.0	1000.0	0.25082525	-692.36016	58 465.610	4.6480202
Conductivity	1000.0	5000.0	0.58847038	-296.13903	29 176.214	1.9487185

TABLE III.—VISCOSITY AND THERMAL CONDUCTIVITY COEFFICIENTS FOR VARIOUS SPECIES (continued)

Type of coefficients	Temperature interval, K		Transport property coefficients $\left.\begin{matrix}\ln\eta\\ \ln\lambda\\ \ln\eta_{(i,j)}\end{matrix}\right\} = A\ln T + \frac{B}{T} + \frac{C}{T^2} + D$			
	Lowest	Highest	A	B	C	D
			CCl_4			
Viscosity	300.0	1000.0	0.52914726	-261.73707	16 983.586	2.2508228
Viscosity	1000.0	5000.0	0.63117223	-50.873987	-37 435.436	1.3896152
Conductivity	300.0	1000.0	0.39796301	-459.70713	25 887.539	3.2182809
Conductivity	1000.0	5000.0	0.60345477	-226.65258	12 105.253	1.5795218
			CF_4			
Viscosity	300.0	1000.0	0.62364242	-15.734540	-11 268.526	1.7826560
Viscosity	1000.0	5000.0	0.52895824	-344.41290	105 727.86	2.6483931
Conductivity	300.0	1000.0	0.29102001	-625.44847	40 137.545	5.0559989
Conductivity	1000.0	5000.0	0.46958735	-718.64138	176 015.42	3.7798145
			$CHClF_2$			
Viscosity	300.0	1000.0	0.55518512	-191.51112	9 230.2454	2.2465942
Viscosity	1000.0	5000.0	0.63832814	-18.642363	-35 632.589	1.5442566
Conductivity	300.0	1000.0	0.57111784	-403.44356	7 684.1854	2.6855196
Conductivity	1000.0	5000.0	0.57237181	-421.44805	17 313.314	2.6852328
			$CHCl_2F$			
Viscosity	300.0	1000.0	0.54261029	-236.93132	14 722.387	2.2950603
Viscosity	1000.0	5000.0	0.63322050	-43.091499	-36 892.355	1.5269221
Conductivity	300.0	1000.0	0.64554399	-296.14334	-3 430.5973	1.8524599
Conductivity	1000.0	5000.0	0.58133799	-384.61009	8 699.9769	2.3723154
			$CHCl_3$			
Viscosity	300.0	1000.0	0.52563815	-280.25371	19 479.241	2.3475804
Viscosity	1000.0	5000.0	0.62913497	-61.794789	-38 001.753	1.4716717
Conductivity	300.0	1000.0	0.43704658	-536.48192	29 187.663	3.2672103
Conductivity	1000.0	5000.0	0.55383193	-510.59645	74 636.570	2.3891512
			CHF_3			
Viscosity	300.0	1000.0	0.58092199	-118.62927	2 503.9931	2.0948315
Viscosity	1000.0	5000.0	0.64363521	-0.70920001	-25 099.472	1.5713073
Conductivity	300.0	1000.0	0.73882642	-170.58713	-32 698.111	1.6126977
Conductivity	1000.0	5000.0	0.58787951	-352.03256	-17 448.254	2.8215977
			CH_2Cl_2			
Viscosity	300.0	1000.0	0.57185884	-345.99168	32 975.791	2.1786059
Viscosity	1000.0	5000.0	0.60922943	-187.84625	-27 411.214	1.8227006
Conductivity	300.0	1000.0	0.25979341	-1051.0041	110 788.50	5.1956543
Conductivity	1000.0	5000.0	0.48080771	-951.20530	171 394.52	3.5085367
			CH_3Cl			
Viscosity	300.0	1000.0	0.58181268	-307.14376	27 516.618	2.0941516
Viscosity	1000.0	5000.0	0.61479454	-163.27574	-27 926.072	1.7778956
Conductivity	300.0	1000.0	0.43048390	-965.86387	91 616.260	4.4424192
Conductivity	1000.0	5000.0	0.44418462	-1157.3896	194 228.38	4.4366915

TABLE III.—VISCOSITY AND THERMAL CONDUCTIVITY COEFFICIENTS FOR VARIOUS SPECIES (continued)

Type of coefficients	Temperature interval, K		Transport property coefficients $\left.\begin{array}{l}\ln \eta \\ \ln \lambda \\ \ln \eta_{(i,j)}\end{array}\right\} = A \ln T + \frac{B}{T} + \frac{C}{T^2} + D$			
	Lowest	Highest	*A*	*B*	*C*	*D*
			CH_4			
Viscosity	200.0	1000.0	0.57643622	-93.704079	869.92395	1.7333347
Viscosity	1000.0	5000.0	0.66400044	10.860843	-7 630.7841	1.0323984
Conductivity	200.0	1000.0	1.0238177	-310.92375	32 944.309	0.67787437
Conductivity	1000.0	5000.0	0.77485028	-400.89627	-46 551.082	2.5671481
			CH_4-O_2			
Binary	300.0	1000.0	0.68971658	-0.82884483	-4 755.7575	1.1497470
Binary	1000.0	5000.0	0.69426262	-17.685146	5 945.2784	1.1244994
			CH_3OH			
Viscosity	300.0	1000.0	0.58408390	-306.77174	27 569.892	1.9794348
Viscosity	1000.0	5000.0	0.61454903	-165.40203	-27 881.995	1.6830713
Conductivity	300.0	1000.0	0.33374512	-1161.7154	108 942.11	5.7684124
Conductivity	1000.0	5000.0	0.42733576	-1268.2528	209 004.63	5.1283860
			CO			
Viscosity	200.0	1000.0	0.62526577	-31.779652	-1 640.7983	1.7454992
Viscosity	1000.0	5000.0	0.87395209	561.52222	-173 948.09	-0.39335958
Conductivity	200.0	1000.0	0.85372829	105.18665	-12 299.753	0.48299104
Conductivity	1000.0	5000.0	0.88506520	134.69656	-11 386.420	0.23610008
			$CO-N_2$			
Binary	200.0	1000.0	0.62526577	-31.779652	-1 640.7983	1.7454992
Binary	1000.0	5000.0	0.87395209	561.52222	-173 948.09	-0.39335958
			$CO-O_2$			
Binary	300.0	1000.0	0.70122551	5.1717887	-1 424.0838	1.2895991
Binary	1000.0	5000.0	0.66744478	-86.348036	27 445.341	1.5855986
			COS			
Viscosity	300.0	1000.0	0.52573161	-276.68290	18 982.511	2.5359860
Viscosity	1000.0	5000.0	0.62947137	-59.744762	-37 616.630	1.6590382
Conductivity	300.0	1000.0	0.56172985	-421.67958	28 198.920	2.6921796
Conductivity	1000.0	5000.0	0.65503267	-171.03349	-50 472.397	1.8756918
			CO_2			
Viscosity	300.0	1000.0	0.51137258	-229.51321	13 710.678	2.7075538
Viscosity	1000.0	5000.0	0.63978285	-42.637076	-15 522.605	1.6628843
Conductivity	300.0	1000.0	0.51435424	-474.44626	31 295.930	3.4128739
Conductivity	1000.0	5000.0	0.67510355	-112.83945	-69 132.618	2.0412787
			CO_2-H_2			
Binary	300.0	1000.0	0.66101867	-40.651732	-4 287.7325	0.74444661
Binary	1000.0	5000.0	0.70351908	19.946369	-13 336.698	0.39931502

TABLE III.—VISCOSITY AND THERMAL CONDUCTIVITY COEFFICIENTS FOR VARIOUS SPECIES (continued)

Type of coefficients	Temperature interval, K		Transport property coefficients $\left.\begin{matrix}\ln \eta \\ \ln \lambda \\ \ln \eta_{(i,j)}\end{matrix}\right\} = A \ln T + \frac{B}{T} + \frac{C}{T^2} + D$			
	Lowest	Highest	A	B	C	D
			CO_2–H_2O			
Binary	300.0	1000.0	0.56499100	-322.19550	26 301.733	2.6351165
Binary	1000.0	5000.0	0.68455483	-33.114757	-58 456.473	1.6048763
			CO_2–N_2			
Binary	300.0	1000.0	0.68926185	-1.3796096	-4 684.7568	1.3060681
Binary	1000.0	5000.0	0.69417954	-18.021840	6 095.0694	1.2779603
			CO_2–O_2			
Binary	300.0	1000.0	0.55753165	-171.40020	7 259.4450	2.4603725
Binary	1000.0	5000.0	0.66011947	25.362441	-39 828.007	1.6020458
			CS_2			
Viscosity	300.0	1000.0	0.54573740	-360.42852	33 177.885	2.3235206
Viscosity	1000.0	5000.0	0.61427787	-153.37427	-36 078.656	1.7122621
Conductivity	300.0	1000.0	0.52603181	-507.80062	41 502.601	2.6684257
Conductivity	1000.0	5000.0	0.66331137	-150.58989	-68 462.565	1.4728865
			C_2H_2, acetylene			
Viscosity	300.0	1000.0	0.56299896	-153.04865	4 601.9734	1.8854528
Viscosity	1000.0	5000.0	0.64038318	-7.2360229	-29 612.277	1.2393032
Conductivity	300.0	1000.0	0.84030505	-100.51610	-26 171.483	1.1926036
Conductivity	1000.0	5000.0	0.62672572	-581.47342	107 517.24	3.0152260
			C_2H_4			
Viscosity	200.0	1000.0	0.59136053	-140.88938	3 001.2800	1.7018932
Viscosity	1000.0	5000.0	0.66000894	39.114999	-52 676.489	1.1033601
Conductivity	200.0	1000.0	0.24736650	-1058.9987	89 911.568	6.4456092
Conductivity	1000.0	5000.0	0.51616035	-924.86351	157 238.87	4.3873845
			C_2H_6			
Viscosity	200.0	1000.0	0.59089348	-139.94405	2 986.8374	1.5988866
Viscosity	1000.0	5000.0	0.66061323	41.062220	-52 656.212	0.99191640
Conductivity	200.0	1000.0	0.70867490	-630.16563	50 951.026	2.9508724
Conductivity	1000.0	5000.0	0.57947247	-649.90228	-3 780.6714	3.9178395
			C_2H_5OH			
Viscosity	300.0	1000.0	0.54586031	-313.82676	26 089.200	2.1078504
Viscosity	1000.0	5000.0	0.61957901	-119.35847	-34 285.357	1.4645259
Conductivity	300.0	1000.0	0.22185435	-1225.1941	117 166.32	6.5571580
Conductivity	1000.0	5000.0	0.42915840	-1212.8199	214 629.28	5.0153152
			C_2N_2			
Viscosity	300.0	1000.0	0.52471007	-288.39713	20 625.913	2.3625791
Viscosity	1000.0	5000.0	0.62832879	-66.440897	-38 542.772	1.4840188
Conductivity	300.0	1000.0	0.76361743	-240.78764	11 152.243	1.3726624
Conductivity	1000.0	5000.0	0.66495585	-197.33792	-59 902.201	2.0817971

TABLE III.—VISCOSITY AND THERMAL CONDUCTIVITY COEFFICIENTS FOR VARIOUS SPECIES (continued)

Type of coefficients	Temperature interval, K		Transport property coefficients $\left.\begin{array}{l}\ln \eta \\ \ln \lambda \\ \ln \eta_{(i,j)}\end{array}\right\} = A \ln T + \frac{B}{T} + \frac{C}{T^2} + D$			
	Lowest	Highest	A	B	C	D
Cl_2						
Viscosity	300.0	1000.0	0.53516134	-236.24735	13 738.454	2.4970463
Viscosity	1000.0	5000.0	0.63348430	-38.786240	-35 830.615	1.6699633
Conductivity	300.0	1000.0	0.34156262	-460.59166	34 712.872	3.7412367
Conductivity	1000.0	5000.0	0.87392526	198.76120	-28 784.264	-0.53204988
D_2						
Viscosity	200.0	1000.0	0.74566381	43.611949	-3 239.6252	0.48064872
Viscosity	1000.0	5000.0	0.96835229	682.41861	-211 297.75	-1.4883773
Conductivity	200.0	1000.0	1.1180891	297.71761	-23 323.095	0.094208300
Conductivity	1000.0	5000.0	1.0670411	498.11245	-149 042.99	0.37216028
D_2O						
Viscosity	300.0	1000.0	0.51773336	-664.13680	82 973.607	2.9575078
Viscosity	1000.0	5000.0	0.58703537	-551.01540	61 063.786	2.3875750
Conductivity	300.0	1000.0	0.74656939	-1059.2831	178 383.77	2.6602773
Conductivity	1000.0	5000.0	0.50642285	-1692.5317	374 934.03	4.7558493
Electron gas						
Viscosity	2000.0	5000.0	5.9319174	5659.4215	-2 257 612.5	-53.458874
Conductivity	2000.0	5000.0	5.9320964	5660.1476	-2 257 733.2	-42.512600
Electron gas–H						
Binary	2000.0	8000.0	1.2321334	2370.6403	-1 467 925.3	-8.9436104
Electron gas–H_2						
Binary	2000.0	8000.0	1.2334840	6001.3628	-4 751 112.3	-9.1540642
Electron gas–NO						
Binary	2000.0	5000.0	0.73575493	5494.6449	-3 658 105.6	-4.2357526
Electron gas–N_2						
Binary	2000.0	5000.0	0.29498917	-688.92058	1 078 957.1	0.59848919
Electron gas–O						
Binary	2000.0	5000.0	-0.41837054	-2253.8475	973 571.06	8.7482646
Electron gas–O_2						
Binary	2000.0	5000.0	-0.78988436	-3446.3790	1 482 143.0	11.081393
F_2						
Viscosity	200.0	1000.0	0.61198519	-39.647960	-1 729.4474	2.1237710
Viscosity	1000.0	5000.0	0.64406091	-0.58273377	-5 224.3255	1.8666294
Conductivity	200.0	1000.0	0.46767823	-266.24115	18 169.657	3.6165585
Conductivity	1000.0	5000.0	-0.19981248	-2512.9092	807 753.79	9.6845049

TABLE III.—VISCOSITY AND THERMAL CONDUCTIVITY COEFFICIENTS FOR VARIOUS SPECIES (continued)

Type of coefficients	Temperature interval, K		Transport property coefficients $\left.\begin{matrix}\ln \eta \\ \ln \lambda \\ \ln \eta_{(i,j)}\end{matrix}\right\} = A \ln T + \frac{B}{T} + \frac{C}{T^2} + D$			
	Lowest	Highest	A	B	C	D
			H			
Viscosity	1000.0	5000.0	0.73837538	-418.72887	193 588.53	0.082985438
Conductivity	1000.0	5000.0	0.73885349	-416.61851	192 632.41	3.5104063
			$H-H^+$			
Binary	2000.0	8000.0	0.63189611	253.77220	-42 087.685	-1.3662852
			$H-H_2$			
Binary	1000.0	5000.0	0.91682562	218.41533	-56 550.107	-0.93253755
			H–Li			
Binary	1000.0	5000.0	0.88426893	237.17354	-64 145.432	-2.3948742
			H–N			
Binary	1000.0	6000.0	0.75223299	-166.19559	101 228.46	-0.027007666
			$H-N_2$			
Binary	200.0	1000.0	0.78865893	47.089566	-2 443.5249	-0.38827113
Binary	1000.0	6000.0	1.2961190	1441.8855	-446 109.51	-4.8448113
			H–O			
Binary	1000.0	5000.0	0.84763422	158.76166	-34 759.786	-1.0617532
			HBr			
Viscosity	300.0	1000.0	0.54286515	-329.09036	28 143.861	2.9266732
Viscosity	1000.0	5000.0	0.61904039	-123.70443	-36 461.217	2.2596924
Conductivity	300.0	1000.0	0.91269760	-154.56150	21 177.636	-0.43914664
Conductivity	1000.0	5000.0	0.63722827	-354.34488	-16 663.585	1.7013527
			HCN			
Viscosity	300.0	1000.0	0.94863717	-148.91490	15 258.721	-0.72592817
Viscosity	1000.0	5000.0	0.57370725	-852.39973	179 536.41	2.4032031
Conductivity	300.0	1000.0	1.1749061	-191.00307	15 714.065	-1.3488014
Conductivity	1000.0	5000.0	0.50543688	-1389.1056	280 031.44	4.2095130
			HCl			
Viscosity	300.0	1000.0	0.54302009	-278.82979	20 927.618	2.5895500
Viscosity	1000.0	5000.0	0.62673906	-81.516979	-35 869.154	1.8707238
Conductivity	300.0	1000.0	0.90670645	-135.61693	18 563.886	0.060312859
Conductivity	1000.0	5000.0	0.62521138	-437.42347	28 720.932	2.2964614
			HF			
Viscosity	300.0	1000.0	0.81674828	-236.35428	22 759.084	0.70625888
Viscosity	1000.0	5000.0	0.58742532	-555.43347	67 637.899	2.5645661
Conductivity	300.0	1000.0	1.2590294	1.1896441	-475.58763	-1.9367617
Conductivity	1000.0	5000.0	0.51518587	-1493.2469	374 820.86	4.3206676

TABLE III.—VISCOSITY AND THERMAL CONDUCTIVITY COEFFICIENTS FOR VARIOUS SPECIES (continued)

Type of coefficients	Temperature interval, K		Transport property coefficients $\left.\begin{array}{c}\ln \eta \\ \ln \lambda \\ \ln \eta_{(i,j)}\end{array}\right\} = A \ln T + \frac{B}{T} + \frac{C}{T^2} + D$			
	Lowest	Highest	A	B	C	D
			$HF-H_6F_6$			
Binary	300.0	1000.0	0.52633473	-328.96634	26 842.682	2.2132195
Binary	1000.0	5000.0	0.62213454	-102.39431	-38 543.254	1.3902717
			HI			
Viscosity	300.0	1000.0	0.53718504	-225.04609	12 416.876	2.7888146
Viscosity	1000.0	5000.0	0.63448421	-33.714923	-34 599.137	1.9723806
Conductivity	300.0	1000.0	0.83653272	-104.34645	9 007.5923	-0.38982280
Conductivity	1000.0	5000.0	0.65866010	-188.46822	-37 866.478	0.96987360
			H_2			
Viscosity	200.0	1000.0	0.74553182	43.555109	-3 257.9340	0.13556243
Viscosity	1000.0	5000.0	0.96730605	679.31897	-210 251.79	-1.8251697
Conductivity	200.0	1000.0	1.0240124	297.09752	-31 396.363	1.0560824
Conductivity	1000.0	5000.0	1.0611992	258.85783	6 316.3191	0.79973205
			H_2-H_2O			
Binary	300.0	1000.0	0.60085490	-67.691161	-2 131.9326	1.4199776
Binary	1000.0	5000.0	0.64550551	10.165601	-18 735.061	1.0502885
			H_2-N_2			
Binary	300.0	1000.0	0.66038264	3.5574798	-957.78014	0.70536614
Binary	1000.0	5000.0	0.62938039	-69.072207	19 855.881	0.97133819
			H_2-O_2			
Binary	300.0	1000.0	0.69018087	-0.23876092	-4 843.2502	0.66856355
Binary	1000.0	5000.0	0.69427291	-17.583177	5 874.8504	0.64692305
			H_2O			
Viscosity	373.2	1075.0	0.49966928	-697.84297	88 274.722	3.0878979
Viscosity	1075.0	5000.0	0.58963330	-538.75152	54 745.230	2.3409644
Conductivity	372.2	1075.0	1.1322991	-512.13867	99 913.498	-0.52900911
Conductivity	1075.0	5000.0	0.50036257	-1719.4289	387 590.61	4.7558670
			H_2O-N_2			
Binary	300.0	1000.0	0.57304553	-148.53813	3 902.9324	2.3462780
Binary	1000.0	5000.0	0.64243064	2.5018380	-36 924.430	1.7567700
			H_2O-O_2			
Binary	300.0	1000.0	0.64727375	-4.2110733	-4 525.5490	1.6510807
Binary	1000.0	5000.0	0.65299406	-17.723412	5 090.6530	1.6154623
			H_2S			
Viscosity	300.0	1000.0	0.54078516	-303.04377	24 073.168	2.4952022
Viscosity	1000.0	5000.0	0.62320319	-98.355396	-37 061.803	1.7823252
Conductivity	300.0	1000.0	0.99442135	-198.49376	18 380.943	-0.19947763
Conductivity	1000.0	5000.0	0.60597875	-563.57581	6 702.7311	2.8605490

TABLE III.—VISCOSITY AND THERMAL CONDUCTIVITY COEFFICIENTS FOR VARIOUS SPECIES (continued)

Type of coefficients	Temperature interval, K		Transport property coefficients $\left.\begin{matrix}\ln \eta \\ \ln \lambda \\ \ln \eta_{(i,j)}\end{matrix}\right\} = A \ln T + \frac{B}{T} + \frac{C}{T^2} + D$			
	Lowest	Highest	A	B	C	D
			H_6F_6			
Viscosity	300.0	1000.0	0.59712969	-367.75006	38 256.100	1.5811495
Viscosity	1000.0	5000.0	0.60263706	-236.19918	-24 765.049	1.4745761
Conductivity	300.0	1000.0	0.82019209	-297.83007	17 372.752	0.94706680
Conductivity	1000.0	5000.0	0.53249125	-759.21725	104 216.49	3.3089772
			He			
Viscosity	200.0	1000.0	0.75015944	35.763243	-2 212.1291	0.92126352
Viscosity	1000.0	5000.0	0.83394166	220.82656	-52 852.591	0.20809361
Conductivity	200.0	1000.0	0.75007833	36.577987	-2 363.6600	2.9766475
Conductivity	1000.0	10000.0	0.83319259	221.57417	-53 304.530	2.2684592
			$He-N_2$			
Binary	300.0	1000.0	0.70110283	5.0670158	-1 412.0743	1.1617449
Binary	1000.0	5000.0	0.66748911	-86.287332	27 458.119	1.4564244
			I_2			
Viscosity	300.0	1000.0	0.54929498	-361.86119	33 655.931	2.6154108
Viscosity	1000.0	5000.0	0.61338027	-159.38416	-35 539.572	2.0394438
Conductivity	300.0	1000.0	0.29817264	-624.70054	63 289.228	3.0234067
Conductivity	1000.0	5000.0	-0.15544742	-2884.3448	966 294.57	7.5135419
			Kr			
Viscosity	200.0	1000.0	0.58597795	-129.24832	4 749.5759	2.5793650
Viscosity	1000.0	5000.0	0.68985845	56.296306	-36 082.600	1.7170715
Conductivity	200.0	1000.0	0.58008139	-137.92556	6 077.1460	1.6420039
Conductivity	1000.0	5000.0	0.68859431	51.765647	-34 512.131	0.74332130
			Li			
Viscosity	1000.0	5000.0	1.3115523	1488.5595	-602 089.53	-5.1797995
Conductivity	1000.0	5000.0	1.3100539	1483.6585	-601 010.02	-3.6638859
			N			
Viscosity	1000.0	6000.0	0.82926975	405.82833	-159 002.42	0.17740763
Conductivity	1000.0	6000.0	0.82928303	405.77643	-158 950.37	0.97751362
			$N-N^+$			
Binary	1000.0	6000.0	0.83858280	26.007230	-17 439.427	-0.32868407
			N-NO			
Binary	2000.0	5000.0	0.80912323	237.89766	-100 889.15	0.38107764
			$N-N_2$			
Binary	2000.0	5000.0	0.86067110	311.83858	-133 357.53	-0.077395277
			N-O			
Binary	1000.0	6000.0	0.71790860	-99.851701	58 263.447	1.2137752

TABLE III.—VISCOSITY AND THERMAL CONDUCTIVITY COEFFICIENTS FOR VARIOUS SPECIES (continued)

Type of coefficients	Temperature interval, K		Transport property coefficients $\left.\begin{array}{r}\ln \eta \\ \ln \lambda \\ \ln \eta_{(i,j)}\end{array}\right\} = A \ln T + \frac{B}{T} + \frac{C}{T^2} + D$			
	Lowest	Highest	A	B	C	D
			$N-O^+$			
Binary	1000.0	6000.0	0.73558367	-151.35611	-33 863.261	0.72530575
			$N-O_2$			
Binary	2000.0	5000.0	0.77353698	190.83623	-80 185.731	0.72225526
			N^+-O			
Binary	1000.0	6000.0	1.1467909	1243.1148	-568 869.59	-2.9117529
			NH_3			
Viscosity	200.0	1000.0	0.56652403	-367.18083	31 663.844	2.2647443
Viscosity	1000.0	5000.0	0.59761003	-280.27339	3 753.2457	1.9910129
Conductivity	200.0	1000.0	1.7498387	291.95254	-33 033.738	-5.0944985
Conductivity	1000.0	5000.0	0.64477673	-912.94723	16 890.182	3.6939751
			NO			
Viscosity	200.0	1000.0	0.60262029	-62.017783	-139.54524	2.0268332
Viscosity	1000.0	5000.0	0.78009050	304.86891	-94 847.722	0.52873381
Conductivity	200.0	1000.0	0.92099219	53.214126	-7 958.5640	0.21559173
Conductivity	1000.0	5000.0	0.84043660	350.26365	-196 758.82	0.66380072
			NO-O			
Binary	1000.0	5000.0	0.75689680	119.39178	-32 511.689	0.90567038
			NO^+-N_2			
Binary	2000.0	5000.0	0.89971008	-1.8323943	1 419.4630	-0.66076677
			NO^+-O			
Binary	2000.0	5000.0	0.89993884	-0.47885775	452.23296	-0.82699506
			NOCl			
Viscosity	300.0	1000.0	0.60503640	-305.99542	28 616.290	2.0637208
Viscosity	1000.0	5000.0	0.60958727	-199.72327	-22 243.863	1.9768724
Conductivity	300.0	1000.0	0.52036442	-537.58642	52 600.561	2.9380096
Conductivity	1000.0	5000.0	0.92835992	135.11240	-79 751.817	-0.42066992
			NO_2			
Viscosity	300.0	1000.0	0.57379100	-126.36034	2 156.6823	2.2287492
Viscosity	1000.0	5000.0	0.64239645	0.60012144	-27 020.876	1.6570566
Conductivity	300.0	1000.0	0.48574998	-507.02110	46 605.820	3.6444556
Conductivity	1000.0	5000.0	0.97660465	727.60751	-325 279.89	-0.60899123

TABLE III.—VISCOSITY AND THERMAL CONDUCTIVITY COEFFICIENTS FOR VARIOUS SPECIES (continued)

Type of coefficients	Temperature interval, K		Transport property coefficients $\left.\begin{array}{r}\ln\eta\\ \ln\lambda\\ \ln\eta_{(i,j)}\end{array}\right\} = A\ln T + \frac{B}{T} + \frac{C}{T^2} + D$			
	Lowest	Highest	A	B	C	D
			N_2			
Viscosity	200.0	1000.0	0.62526577	-31.779652	-1 640.7983	1.7454992
Viscosity	1000.0	5000.0	0.87395209	561.52222	-173 948.09	-0.39335958
Conductivity	200.0	1000.0	0.85372829	105.18665	-12 299.753	0.48299104
Conductivity	1000.0	5000.0	0.88506520	134.69656	-11 386.420	0.23610008
			N_2–O			
Binary	1000.0	5000.0	0.78796319	147.17936	-40 476.885	0.62473150
			N_2–O^+			
Binary	2000.0	5000.0	0.89991632	-0.41877985	279.72851	-0.83904181
			N_2–O_2			
Binary	300.0	1000.0	0.70122551	5.1717887	-1 424.0838	1.2895991
Binary	1000.0	5000.0	0.66744478	-86.348036	27 445.341	1.5855986
			N_2O			
Viscosity	200.0	1000.0	0.58959112	-155.65178	3 763.0431	2.1223853
Viscosity	1000.0	5000.0	0.64571469	-8.8806585	-41 560.559	1.6332498
Conductivity	200.0	1000.0	0.65165376	-343.73058	15 090.399	2.4242359
Conductivity	1000.0	5000.0	0.64720604	-78.680195	-119 657.29	2.3246569
			N_2O_4			
Viscosity	300.0	1000.0	0.52508683	-286.52689	20 354.406	2.5287873
Viscosity	1000.0	5000.0	0.62841605	-65.798081	-38 345.315	1.6529852
Conductivity	300.0	1000.0	0.33364942	-687.02644	52 625.318	4.7685793
Conductivity	1000.0	5000.0	0.59441359	-262.39268	-29 309.960	2.6245858
			Na			
Viscosity	1000.0	5000.0	1.3178841	1332.6658	-427 779.11	-4.7824549
Conductivity	1000.0	5000.0	1.3159782	1325.9177	-425 128.42	-4.4603931
			Ne			
Viscosity	200.0	1000.0	0.68398511	18.732366	-2 366.3189	1.8284755
Viscosity	1000.0	5000.0	0.72333495	104.20872	-25 429.545	1.4942434
Conductivity	200.0	1000.0	0.68509965	19.794924	-2 452.5539	2.2586136
Conductivity	1000.0	5000.0	0.72278122	105.28290	-26 355.706	1.9367337
			O			
Viscosity	1000.0	6000.0	0.77461166	92.418257	-62 500.795	0.83317089
Conductivity	1000.0	6000.0	0.77466803	92.729443	-62 674.343	1.4998498
			O–O^+			
Binary	1000.0	6000.0	0.98503448	675.64757	-329 575.12	-1.4363908

TABLE III.—VISCOSITY AND THERMAL CONDUCTIVITY COEFFICIENTS FOR VARIOUS SPECIES (continued)

Type of coefficients	Temperature interval, K		Transport property coefficients $\left.\begin{matrix}\ln \eta \\ \ln \lambda \\ \ln \eta_{(i,j)}\end{matrix}\right\} = A \ln T + \frac{B}{T} + \frac{C}{T^2} + D$			
	Lowest	Highest	*A*	*B*	*C*	*D*
			$O-O_2$			
Binary	1000.0	5000.0	0.73247184	99.313096	-26 815.031	1.1224438
			OH			
Viscosity	300.0	1000.0	0.76892924	-263.43285	24 746.805	1.0326028
Viscosity	1000.0	5000.0	0.59502803	-467.37406	39 767.529	2.4227902
Conductivity	300.0	1000.0	1.2335495	-93.048739	3 844.0086	-1.5693877
Conductivity	1000.0	5000.0	0.54743881	-1206.0985	217 314.87	4.0696759
			O_2			
Viscosity	200.0	1000.0	0.60916180	-52.244847	-599.74009	2.0410801
Viscosity	1000.0	5000.0	0.72216486	175.50839	-57 974.816	1.0901044
Conductivity	200.0	1000.0	0.77238828	6.9293259	-5 900.8518	1.2202965
Conductivity	1000.0	5000.0	0.90875998	289.86028	-79 180.433	0.068622859
			SF_6			
Viscosity	300.0	1000.0	0.49748474	-218.64084	14 509.989	2.7631958
Viscosity	1000.0	5000.0	0.60769589	-142.30978	31 449.312	1.9086137
Conductivity	300.0	1000.0	0.41857258	-197.33612	-25 661.949	3.4555207
Conductivity	1000.0	5000.0	0.60633905	44.458129	-52 676.509	1.9436963
			SO_2			
Viscosity	300.0	1000.0	0.53157084	-295.89873	21 224.840	2.5975549
Viscosity	1000.0	5000.0	0.60783098	-192.83581	7 823.2002	1.9811072
Conductivity	300.0	1000.0	0.61476551	-564.09295	49 580.787	2.3940064
Conductivity	1000.0	5000.0	0.53617558	-694.13085	75 304.908	3.0412002
			$SiCl_4$			
Viscosity	300.0	1000.0	0.52724861	-269.92512	18 062.726	2.2413435
Viscosity	1000.0	5000.0	0.63025696	-55.616232	-37 587.506	1.3711284
Conductivity	300.0	1000.0	0.48928637	-340.31669	15 336.652	2.3608171
Conductivity	1000.0	5000.0	0.62189282	-146.44974	-15 293.955	1.2815679
			SiF_4			
Viscosity	300.0	1000.0	0.59609697	-79.178529	-1 591.5012	1.9580540
Viscosity	1000.0	5000.0	0.64527457	10.348180	-21 766.101	1.5489951
Conductivity	300.0	1000.0	0.44281914	-380.82561	16 794.039	3.5456135
Conductivity	1000.0	5000.0	0.62544021	-111.92686	-26 345.285	2.0583524
			SiH_4			
Viscosity	300.0	1000.0	0.57519423	-123.26162	1 882.4028	1.8761319
Viscosity	1000.0	5000.0	0.64257687	1.2846016	-26 699.436	1.3147047
Conductivity	300.0	1000.0	0.55408670	-643.39630	55 747.611	3.7641386
Conductivity	1000.0	5000.0	0.56234379	-449.31035	-37 165.926	3.6059282

TABLE III.—VISCOSITY AND THERMAL CONDUCTIVITY COEFFICIENTS FOR VARIOUS SPECIES (concluded)

Type of coefficients	Temperature interval, K		Transport property coefficients $\left.\begin{array}{r}\ln \eta \\ \ln \lambda \\ \ln \eta_{(i,j)}\end{array}\right\} = A \ln T + \frac{B}{T} + \frac{C}{T^2} + D$			
	Lowest	Highest	A	B	C	D
UF_6						
Viscosity	300.0	1000.0	0.56019928	-159.78215	5 286.6529	2.4249812
Viscosity	1000.0	5000.0	0.63981806	-9.5366264	-30 026.765	1.7600620
Xe						
Viscosity	200.0	1000.0	0.57988418	-188.06666	10 508.723	2.6502107
Viscosity	1000.0	5000.0	0.68506945	47.671749	-54 767.718	1.7531546
Conductivity	200.0	1000.0	0.57308328	-199.91432	12 872.027	1.2718931
Conductivity	1000.0	5000.0	0.68319650	40.020092	-52 038.474	0.33623407

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13. ABSTRACT ***(Maximum 200 words)***
This report documents the new transport property data that will be used in the NASA Lewis Research Center's Chemical Equilibrium and Applications Program (CEA). It complements a previous publication that documented the thermodynamic and transport property data then in use. Sources of the data and a brief description of the method by which the data were obtained are given. Coefficients to calculate the viscosity, thermal conductivity, and binary interactions are given for either one, or usually, two temperature intervals, typically 300 to 1000 K and 1000 to 5000 K. The form of the transport equation is the same as used previously. The number of species was reduced from the previous database. Many species for which the data were estimated were eliminated from the database. Some ion-neutral interactions were added.

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